MOSFN0703532

COMBINED PRELIMINARY ASSESSMENT/SITE INSPECTION REPORT

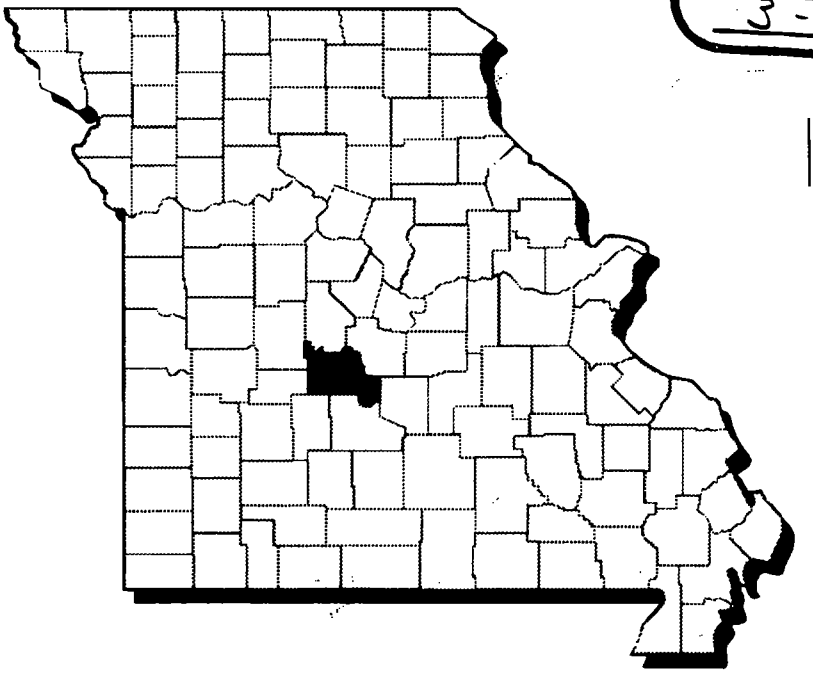
Camdenton Sludge Disposal Area Site
Camden County, Missouri

March 30, 1999

#143099

Site: Camdenton Sludge
ID #: MOSFN0703532
Break: 1.5
Other:
3-30-99

143099



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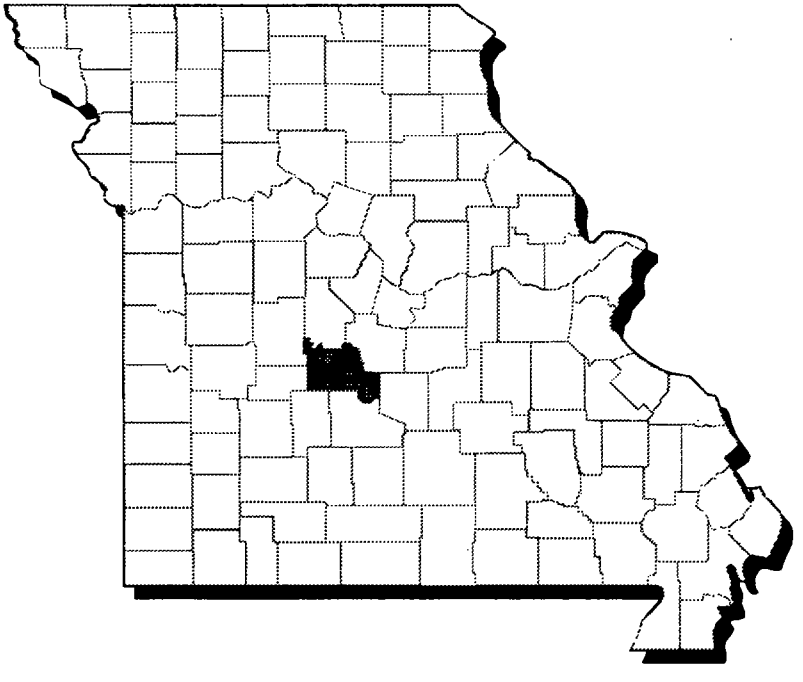

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DATE: March 30, 1999

PREPARED BY: Valerie H. Wilder
Missouri Department of Natural Resources

SITE: Camdenton Sludge Disposal Area
Camden County

C.A. NUMBER: V997381-98-0

EPA ID. NUMBER:

1.0 INTRODUCTION

Under the authority of the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) and the Superfund Amendments and Reauthorization Act of 1986 (SARA), the Missouri Department of Natural Resources (DNR), through a cooperative agreement with the U.S. Environmental Protection Agency (EPA), conducted a Combined Preliminary Assessment/Site Inspection (PA/SI) at the Camdenton Sludge Disposal Area Site in Camden County, Missouri. The Camdenton Sludge Disposal Area is the site where sludge from the Hulett Lagoon, one of the City of Camdenton's wastewater lagoons, was deposited as part of closure. The Hulett lagoon is located in the City of Camdenton, over four miles from the Camdenton Sludge Disposal Area site, and is being investigated separately as the Former Hulett Lagoon site. The Former Hulett Lagoon site has documented trichloroethene (TCE) contamination in the soil and groundwater on-site. Investigation of the sludge disposal area was initiated due to the potential for a release of hazardous substances from the sludge into the environment in the area where it was disposed.

The purpose of this investigation was to collect sufficient information concerning conditions at the site to assess the threat posed to human health and the environment, and to determine the need for additional investigation under CERCLA/SARA or other authority. The scope of the investigation included review of previous file information, sampling of waste and environmental media to document Hazard Ranking System (HRS) factors, and collecting additional non-sampling information. Investigation included site visits on December 1, 16, 1998 and site sampling on January 6, 22, 29, 1999. The PA/SI was initiated on October 27, 1998.

2.0 SITE DESCRIPTION

2.1 Location

The Camdenton Sludge Disposal Area site is located on County Road 5-120, southeast of the Camdenton Memorial Airport. The site is located on city property, but is actually three miles southeast of Camdenton City limits (Reference 3). Geographic coordinates for the site are 37°58'08.7" north latitude and 92°41'14.7" west longitude (Reference 4). The site is in the Northwest 1/4 of the Southeast 1/4 of the Southeast 1/4 of Section 4, Township 37 North, Range 16 West in Camden County. Figure 1 in Appendix A is a site location map (Reference 3).

The Camdenton Sludge Disposal Area can be accessed from the intersection of U.S. Highway 54 and State Route 5 in Camdenton by taking State Route 5 southeast for 4.4 miles to County Road 5-120; take a left onto CR 5-120 (unimproved road) and travel east. The disposal area is 0.3 of a mile down the road on the north side (Reference 5).

The Camdenton area receives an average of 42.32 inches of precipitation annually, and an average of 19 inches of snowfall annually (Reference 6, p. 2). The maximum expected two-year, 24-hour rainfall is approximately 3.5 inches (Reference 7). The average daily temperature during the summer months is 77° F, and the average winter temperature is 35° F (Reference 6, p. 2). The average wind speed and direction is approximately 10 miles per hour from the south (Reference 8, p. 74).

2.2 Site Description

The following description of the Hulett lagoon is included to provide pertinent background information. The former Hulett lagoon is a closed wastewater sewage lagoon that was operated by the City of Camdenton from 1961 to 1988. The lagoon was approximately one acre in size, located in the City of Camdenton, northeast of the intersection of Dawson Road and Sunset Drive. Photos 1 and 2 were taken in October 1974 when the lagoon was operating. Photo 1 shows the north side of the lagoon where an influent pipe from a city sewer line entered the lagoon. Photo 2 shows the south side of the lagoon where an influent pipe from an industrial facility entered the lagoon. A great deal of sludge settling around the influent is visible. In 1989, the lagoon was closed; the water was drained and the sludge was removed (Reference 9, p. 12). Photo 3 was taken during the dewatering process.

The Camdenton Sludge Disposal Area is located in a rural area three miles southeast of Camdenton. The site is an open field with mixed vegetation (Photo 4). At the time of disposal, 42.4 acres were set aside for the sludge application, however, the actual area of sludge disposal may have been considerably less that 42 acres. The sludge disposal area consisted of a designated circular stockpiling area located approximately 150 feet from the county road, and two designated field areas that were to be used for disposal (see Figures

4 and 5 in Appendix A) (Reference 10) (Photos 5, 6). The outline of the stockpiling area is faintly discernable today (Photo 7). The spreader used during the sludge disposal operation was left on-site and is situated approximately 100 yards northwest of the stockpiling area (Photo 8). There are no other structures in the area. Most drainage for the site flows into a low ditch that runs west to east across the southern portion of the site (Photos 9, 10) (Reference 5).

The sludge disposal area is bordered on the south by County Road 5-120; on the north by the Camdenton Memorial Airport; on the west by a residence; and on the east by a wooded area. Access to the site is not restricted. There is no fencing or gates (Reference 5).

2.3 Operational History of Hulett Lagoon

The following section includes pertinent background information regarding operations at the Hulett lagoon. The City of Camdenton, Missouri, currently owns the former Hulett lagoon property as well as the property near the airport where the sludge was disposed. The Hulett lagoon was constructed in 1961 under the State of Missouri Grants Program. The lagoon was constructed of clay, and its berms were approximately 25 feet wide and 15 feet high (Reference 9, p. 12).

The Hulett lagoon was in operation from 1961 until its closure in late 1989. It was one of five municipal lagoons that serviced the City of Camdenton, however, it was the only lagoon that received industrial effluent in addition to domestic sewage. From 1967 through 1986 a nearby manufacturing facility released untreated wastewater and storm water into the lagoon through a series of "mudpits", or sumps, via a storm sewer. Heat transfer components for commercial and automotive industries are manufactured at the facility. The untreated wastewater was known to have contained several hazardous waste streams including corrosive waste, wastewater treatment sludges from electroplating operations, and waste oil. In addition, residual contaminants associated with degreasing operations, including TCE, was discharged into the mud pits and ultimately into the Hulett lagoon (References 9, p. 12; 11, p. 1; 16, p. 8).

The manufacturing facility was owned and operated by Dawson Metal Products, Inc. from 1966 to 1972. Sundstrand Tubular Products, Inc. owned and operated the facility from 1972 to 1990. In 1990 Modine Manufacturing Company bought the facility, and continues operation today (Reference 12). The facility generated TCE waste during degreasing operations from the early 1970's to December 1990 (Reference 13, p. 1).

On May 22, 1984, the City of Camdenton collected samples of the Hulett lagoon water, Sundstrand's influent to the lagoon, housing influent to the lagoon, effluent from the lagoon, and water near Lake of the Ozarks. Results showed 41 parts per billion (ppb) TCE in the Sundstrand influent and 28 ppb TCE in the effluent from the lagoon (Reference 14).

On July 19, 1984, additional samples of Sundstrand's effluent and lagoon water were collected. This Sundstrand effluent sample showed 4,900 ppb TCE in addition to 7,600 ppb total chromium, 29,000 ppb total copper, and 1,400 ppb total zinc. The sample from the lagoon showed 500 ppb TCE, 500 pbb total chromium, 200 ppb hexavalent chromium, 4100 ppb total copper and 230 ppb total zinc (Reference 15).

In 1988, the City of Camdenton began closure of the Hulett Lagoon pursuant to an Industrial Development Grant overseen by DNR's Water Pollution Control Program (WPCP). As per DNR guidelines for closing out municipal lagoons, sampling and analysis of the sludge in the lagoon was limited to metals and other parameters such as total solids. High levels of chromium, lead, and nickel were detected (Reference 16). DNR offered the City officials several options to consider in completing the closure of the lagoon (Reference 17). The option chosen and implemented by the city was subsurface application of the sludge from the lagoon to a sludge disposal site owned by the city. DNR approved the sludge disposal plan on February 22, 1989 (Reference 18).

The city's engineering consultant, Missouri Engineering Corporation, supervised the lagoon closure project. In June 1989, McCormick Gravel & Excavating of Versailles, Missouri was awarded the contract for the removal, stockpiling and disposal of sludge from the lagoon. The contract included lagoon dewatering, preparation, transportation, and stockpiling of the sludge, as well as disposal by land application at the sludge disposal area (References 10; 19).

The specifications called for the contractor to pump the water from the lagoon and discharge it into the existing sewer manhole approximately 100 feet away (Reference 10). The process of removing the sludge at the lagoon began on July 11, 1989 and was completed sometime in late September 1989. Lime was added to the sludge at the lagoon to raise the pH and immobilize the metals. The project contract was originally written with an estimate of 1,500 cubic yards of sludge to be removed. However, due in part to an unusually high amount of rain during the removal process, the sludge did not dry out and shrink, as it should have. In addition, the rainfall caused the sludge to be spread across the lagoon contaminating more soil. The lagoon had to be pumped again and the sludge allowed to dry. A small amount of soil then had to be removed along with the sludge. When that portion of the project was completed, an estimated 2,395 cubic yards of sludge had been removed (References 20; 21; 22). The berms of the lagoon were turned in and mixed in a 1 to 1 ratio (Reference 23).

2.4 Camdenton Sludge Disposal Site History

Activities at the Camdenton Sludge Disposal Area site began in July 1989. Prior to this, the site was owned by the city, and was part of the airport, but was not used for any particular purpose. The sludge was transported by truck to the designated area off County Road 5-120, which is south of the Camdenton Memorial Airport runway. The sludge was stockpiled in the designated storage facility region, a circular area 120 feet in diameter

located 150 feet from County Road 5-120. Figure 4 in Appendix A is a planning map from the City of Camdenton's Specifications and Contract Document that shows the sludge disposal area near the airport. In December 1989, after allowing the sludge to dry, the contractor began spreading the sludge with a dry sludge applicator onto the designated fields at the airport, mixing it with additional soil and discing the sludge into the ground. During the mixing, soils tests were reportedly taken to demonstrate that the loading was below the specified levels. (Reference 22). Figure 5 in Appendix A is a wider view planning map that shows the designated fields to be used for disposal.

The mixing, spreading and discing continued through March 1990. Apparently, rain and snow delayed completion of the spreading (Reference 22). City employees who observed some of the spreading activity reported the sludge was more difficult to spread evenly than was originally anticipated. It didn't dry out completely and would stick together in clumps. Near the end of the process, it was reported that the last several piles of sludge transported to the area were simply dumped into the ditch located about 50 feet north of the circular storage area. It was not spread, mixed or disced (Reference 5).

In March 1990, the fields were seeded with a mix of Timothy and Fescue grasses in order to provide ground cover and prevent erosion. In April 1990, the pH of the soils in the fields was tested to ensure a level of 6 was achieved. Anything below 6 would be mixed with lime to raise the pH (Reference 22).

Referral of Former Hulett Lagoon to Superfund Section

On September 8, 1998 the Permits Section of the Hazardous Waste Program formally referred investigation of the former Hutlett Lagoon and the Camdenton Sludge Disposal Area to the Superfund Section of the HWP. The Permits Section is currently negotiating a Corrective Action Abatement Order on Consent (AOC) with the Modine Manufacturing Company to investigate contamination present on the Modine property. Investigation of the Hulett Lagoon is not included in the AOC, however, because in addition to receiving wastewater from the facility at 179 Sunset Drive, the lagoon also received domestic sewage from the surrounding residences. A dye trace study of the City of Camdenton's sewer system performed by the Division of Geology and Land Survey (DGLS) on August 5, 1998, verified that facility wastewater mixed with domestic sewage prior to entering city property (Reference 24).

According to 40 CFR 261.4(a)(1), domestic sewage and any mixture of domestic sewage and other wastes that pass through a sewer system to a publicly owned treatment works (POTW) are not considered solid wastes, and thus would not be considered hazardous wastes. The facility that disposes of such wastes is excluded from RCRA permitting requirements, which is why the Hulett Lagoon site was referred to Superfund to be addressed under CERCLA. CERCLA has no such exemption.

Although the Former Hulett Lagoon and the Camdenton Sludge Disposal Area sites are related to each other with respect to their history and origin of contamination, they are more than 4.5 miles apart, which warranted investigating them as two separate sites.

2.5 Waste Characteristics

Analytical results from soil sampling show chromium contamination above background and above Superfund Chemical Data Matrix (SCDM) health-based benchmarks. Copper, lead, mercury, nickel, selenium, silver, ethylbenzene, toluene, and total xylenes were detected above background, but none of the levels exceeded SCDM benchmarks.

Chromium is a naturally occurring metal in the environment. It binds to soil and other materials in water and settles to the bottom. A small amount may dissolve in the water. Soluble chromium compounds can remain in water for years before settling to the bottom. Fish do not accumulate much chromium in their bodies from water. Most of the chromium in the soil does not dissolve easily in water and can attach strongly to the soil. A small amount in the soil will dissolve in water and can move deeper in the soil to underground water. In humans, very little chromium enters the body through skin contact unless the skin is damaged. Low levels of chromium exposure will eventually be passed through the body. Chromium is classified as a carcinogen (certain compounds), hazardous substance (certain compounds), hazardous waste constituent and priority toxic pollutant by EPA (References 25, pp. 1-4; 26, p. 243)

Trichloroethene
Information regarding TCE is included because it is a contaminant of concern at this site even though none was detected in the soil samples on-site. The lagoon is known to have been contaminated with TCE; it is suspected the sludge did contain TCE at one time. TCE was detected in private drinking water wells near the sludge disposal area.

TCE is a nonflammable, colorless liquid at room temperature with a somewhat sweet odor and sweet, burning taste. The manmade chemical does not occur naturally in the environment. TCE is now mainly used as a solvent to remove grease from metal parts. It is also used as a solvent in other ways and is used to make other chemicals. TCE evaporates easily into the air but can persist in the soil and groundwater. Once TCE is in surface water, much of it will evaporate into the air. It will take days to weeks to break down in surface water; in groundwater, the breakdown is much slower because of the slower evaporation rate. Very little TCE breaks down in the soil, and it can pass through the soil into underground water (Reference 27, pp. 1, 2).

TCE can enter the body from breathing air or drinking water containing TCE. It can also enter through the skin, but not as easily as by breathing or drinking. If the chemical is inhaled, about half will enter the bloodstream and organs; the remaining is exhaled. If TCE is swallowed, most will be absorbed into the blood. The liver changes most of the TCE to other chemicals and the majority of these breakdown products leave the body in the urine

within a day. Some of the common symptoms to TCE exposure (usually at high levels) are headaches, dizziness, and rashes. Laboratory animals that were exposed to moderate levels of TCE had enlarged livers, and high-level exposure caused liver and kidney damage. However, it is not known if these changes would occur in humans. TCE is considered an animal carcinogen (Reference 27, pp. 1-4).

TCE is known as a Dense Nonaqueous Phase Liquid (DNAPL). DNAPLs are separate-phase hydrocarbon liquids that are denser than water. DNAPLs can exist in the soil/aquifer matrix in free-phase form or in residual form. When released on the ground's surface, free-phase DNAPLs move downward through the soil matrix under the force of gravity or laterally along the surface of sloping fine-grained stratigraphic units. As free-phase DNAPLs move, residual amounts are trapped in pores and/or fractures by capillary forces. Trapped DNAPLs are known as residual saturation. This residual saturation is a function of the physical property of the DNAPL and the hydrogeologic characteristics of the soil/aquifer medium, which typically ranges from 5-50% of total pore volume (Reference 28).

Most DNAPLs undergo only limited degradation in the subsurface and persist for long periods of time, while slowly releasing soluble organic constituents to groundwater through dissolution. Dissolution may continue for hundreds of years under natural conditions before the DNAPL is dissipated (Reference 28).

3.0 WASTE/SOURCE SAMPLING

3.1 Sample Locations (Reference 29)

PA/SI soil sampling in the sludge disposal area was conducted on January 22, 1999. Figure 2 in Appendix A is a site map that shows collection location of all soil samples collected in the sludge disposal area. A membrane interface probe (MIP), equipped with a photo ionization detector (PID) and a flame ionization detector (FID), was employed to generate soil gas data of the subsurface within and surrounding the boundaries of the former lagoon area. The soil gas data was used, in part, to determine actual sampling locations.

Ten soil borings (Hulett-11 through Hulett-20) were drilled to collect eight soil source samples from the sludge disposal area and two background samples from outside the area. Five of the nine borings (Hulett 12, 13, 14, 18, 19) were focused in the area near the main ditch. The source samples were collected generally from two depth zones. Near surface samples (0.5'-1') were collected in an attempt to locate actual sludge material. Subsurface samples (5'-8') were collected in an attempt to determine whether any potential contamination from the sludge may have migrated downward. Refusal, meaning bedrock, was generally encountered at depths ranging from 5 to 8 feet. The background boring was drilled just north of County Road 5-120 approximately 25 feet southwest of the sludge

disposal area. The background samples were collected from a 0.5'-1' depth and 5.5'-6' depth, which corresponds approximately with the depth zones of the source samples.

3.2 Analytical Results (Reference 29)

Reference 29, Appendix B contains the MIP data logs generated for each boring. The logs indicate detections noted on the MIP's PID (identified as "Detector 1") and the FID ("Detector 2"). Small detections on the MIP's PID and FID in borings Hulett 12, 18 and 19 indicated there may be some volatile organic compounds present. Detections only on the FID for borings 15, 16 and 17 indicated methane might be present.

Table 1, on the following page, presents selected analytical results for all soil samples collected by DNR as part of the PA/SI. All soil samples were analyzed for total metals (arsenic, barium, cadmium, chromium, copper, lead, mercury, nickel, selenium, and silver) and VOCs. Chemicals that were non-detect in all samples are not listed in the table. If any sample's total analyte levels exceeded 80% of 20 times the Toxicity Characteristic Leaching Procedure (TCLP) regulatory limit for a particular analyte, TCLP analysis was performed on that sample.

Green sludge material was encountered in borings Hulett 12 and Hulett 19, from the ditch area. Analytical results from samples 991478 and 991483 (0.5'-1' depth) showed total levels of chromium, copper, lead, and nickel significantly above background, although none of the TCLP results exceed regulatory limits. Only the chromium concentrations exceed SCDM benchmarks; only one chromium concentration exceeds the Missouri Department of Health's published Any-Use Soil Level (ASL) for chromium. Low levels of ethylbenzene, toluene and total xylenes were detected in sample 991483.

3.3 Waste/Source Conclusions

Over 2,000 cubic yards of sludge from the Hulett lagoon was deposited in a 20-40 acre tract at the Camdenton Sludge Disposal Area site. The majority of PA/SI sampling focused on the region near the main ditch in the disposal area. Reportedly, several loads of sludge were deposited into this ditch near the end of the project without any mixing, discing or spreading. Recognizable sludge material was encountered in two soil borings from the ditch. Levels of chromium, copper, lead and nickel were documented significantly above background in these two samples. Chromium, however, was the only compound detected that was present at a level exceeding the SCDM benchmarks and the MO ASL. TCE was not detected in any of the eight soil samples collected from the disposal area.

Camdenton Sludge Disposal Area
Combined PA/SI
March 30, 1999

TABLE 1: SELECTED ANALYTICAL RESULTS FROM SOIL SAMPLES COLLECTED IN/NEAR THE CAMDENDTON SLUDGE DISPOSAL AREA

All results in parts per million (ppm) * soil saturation level substituted for ASL NA - not analyzed NL - not listed
Underlined results are those that are three times above background or above the detection limit if the background concentration is below the detection limit
Bolded results are those that are above background and exceed SCDM Benchmark and/or MO ASL

	Hulett-11	Hulett-12		Hulett-17	Hulett-18	Hulett-19			Hulett-20		SCDM	MO	MO
	0.5' – 1'	0.5' – 1'	8.5' – 9'	0.5' – 1.5'	5.5' – 6'	0.5' – 1'	7' – 7.5'	7' – 7.5'	0.5' – 1'	5.5' – 6'	Bnchmrk	ASL	CALM C_{LEACH}
	991476 stockpile	991478 sludge	991477	991479	991480	991483 sludge	991481	991482 replicate	991484 background	991485 background			
METALS													
Arsenic, total	7.46	8.78	4.98	5.97	7.08	19.7	4.94	5.76	8.74	34	0.0043	11	NL
Barium, total	170	280	139	105	93.7	253	69	82.6	206	195	5500	3900	1650
Cadmium, total	<0.2	0.782	<0.2	<0.2	0.216	1.55	<0.2	<0.2	<0.2	0.409	39	28	11
Chromium, total	33.1	**1640**	27.5	34.7	74.8	**7830**	38.8	43.9	38.1	110	390	5600	38
Chromium, TCLP	NA	0.0463	NA	NA	NA	0.041	NA	NA	NA	<0.004			
Copper, total	9.45	1890	10.4	6.79	7.12	11200	8.67	11.4	14.6	32	NL	NL	NL
Lead, total	21.8	66.2	19.2	17.3	19.4	121	13.5	16.6	26.3	67.6	NL	240	NL
Lead, TCLP	NA	NA	NA	NA	NA	<0.0411	NA	NA	NA	NA			
Mercury, total	<0.04	0.314	<0.04	<0.04	<0.04	0.195	<0.04	<0.04	0.0819	<0.04	23	17	3.23
Nickel, total	12.3	29.9	15.5	11.4	9.33	129	8.4	9.4	15.5	42.7	1600	1100	170
Selenium, total	<1	<1	<1	<1	<1	1.03	<1	<1	<1	<1	390	280	4.37
Silver, total	<1	<1	<1	<1	<1	3.17	<1	<1	<1	<1	390	280	255
VOCs													
Ethylbenzene	<0.025	<0.025	<0.025	<0.025	<0.025	0.023	<0.025	0.018	<0.025	<0.025	58	340	0.097
Toluene	<0.025	<0.025	<0.025	<0.025	<0.025	0.03	<0.025	<0.025	<0.025	<0.025	58	340	0.097
Total Xylenes	<0.025	<0.025	<0.025	<0.025	<0.025	0.084	<0.025	<0.025	<0.025	<0.025	58	340	0.097

4.0 GROUNDWATER PATHWAY

4.1 Hydrogeologic Setting (Reference 30)

Stratigraphic Units

A stratigraphic column (Table 2 on page 14) has been tabulated based upon the stratigraphy of nearby wells. The youngest bedrock formation beneath the site is the Ordovician-age Roubidoux Formation, assigned to the Canadian Series. The Roubidoux Formation consists of dolomite, sandy dolomite, and sandstone. In the Camdenton area, soluble portions of the Roubidoux have generally been removed by dissolution. Nearby well logs indicate that the Roubidoux Formation may consist of clayey residuum and sandstone, with only small lenses of carbonate rock remaining. In the headwaters of Racetrack Hollow, approximately ½ mile west of the site, erosion has completely removed the Roubidoux Formation and the underlying Gasconade Dolomite is exposed at the surface. Approximately 1½ miles northeast of the site, Jefferson City Dolomite exposures overlie the Roubidoux Formation.

Underlying the Roubidoux Formation, the Gasconade Dolomite consists of cherty dolomite and is estimated to be approximately 280 feet thick in the vicinity of the site. A basal unit of the Gasconade Dolomite, known as the Gunter Sandstone Member, commonly separates the Ordovician- and Cambrian-age strata. The Gunter Sandstone is approximately 25 feet thick in the Camdenton Airport area.

Cambrian rocks in the Camdenton area were deposited in a complex depositional environment. The Camdenton Sludge Disposal Area is located near the western margin of a Cambrian-age intrashelf sedimentary basin known as the Central Missouri Basin. During Cambrian time, the Camdenton area was part of an emerging tectonic feature known as the Lebanon Arch. The north-south trending Lebanon Arch consists of carbonate platform rocks, that in some areas, thin over Precambrian highlands. The boundary between the Central Missouri Basin and the Lebanon Arch is transitional and poorly defined. Dramatically different lithologies and abrupt facies changes are depicted in area well logs. In general, more shaly, basinal rocks to the east pinch-out against the Lebanon Arch.

Because of the tectonic setting, Cambrian beds in the Camdenton area are difficult to categorize, and "layer-cake" stratigraphy should not be assumed. The following descriptions are simplified. The upper-most Cambrian unit in the area is the Eminence Dolomite, which consists of approximately 240 – 635 feet of dolomite with minor amounts of chert. The Eminence Dolomite is underlain by about 25 - 230 feet of Potosi Dolomite, which consists of dolomite, chert, and drusy quartz. Beneath the Potosi Dolomite, in descending order, are the Derby-Doerun Dolomite, the shaly Davis Formation, the Bonneterre Formation, and the Lamotte Sandstone. The entire Cambrian section is estimated to be over 1,150 feet thick.

Aquifers

The Ozark Aquifer, which includes all bedrock units above the Cambrian-age Derby-Doerun Dolomite, is the shallowest aquifer beneath site. The Ozark Aquifer is considered exposed at the surface at the Camdenton Sludge Disposal Area. The total thickness of the aquifer is approximately 950 feet. Each of the units which comprise the Ozark Aquifer have individual characteristics that control their water-bearing capabilities; however, in general, the Ozark Aquifer produces good-quality water, with production rates generally proportional to well depth.

There can be perhaps as many as three separate potentiometric surfaces within in the Ozark Aquifer in upland areas such as the Camdenton Sludge Disposal Area. Water levels in upland wells completed in the Roubidoux Formation range from 18 to 205 feet below the surface. However, it is possible that the Roubidoux Formation present beneath this particular site is too thin to contain groundwater. Water levels in upland wells completed in the Gasconade Dolomite range from 14 to 300 feet below the surface, with an average depth to water of 150 feet. Water levels in upland wells completed in the Eminence Dolomite and deeper formations range from 15 to 407 feet below the surface, with an average depth to water of 200 feet. The multiple water-level phenomenon common in upland areas suggests significant local recharge to the deeper portions of the Ozark Aquifer.

Differences in head between shallow and deep portions of the Ozark Aquifer are typical in upland areas such as the Camdenton Sludge Disposal Area. The site is expected to be a groundwater recharge zone. Extensive pumping of deeper groundwater can increase the downward vertical gradient. Camden County PWSD #2 Well #1 is reportedly used only once per week with the bulk of water being supplied by Well #2 located approximately 3 miles south of the Camdenton Sludge Disposal Area. Nearby domestic wells can also contribute to an increase in downward gradient. Pumping rates at the Camden County PWSD #2 Well #1 may be high enough to engulf the site within a cone of depression. The radius of influence of nearby production wells should be determined.

Because detailed hydrogeologic studies have not been conducted at the site, groundwater flow directions within the bedrock can only be approximated. According to the potentiometric map of the Roubidoux-Gasconade sequence in "Hydrology of Carbonate Terrane – Niangua, Osage Fork, and Grandglaize Basins, Missouri", shallow groundwater beneath the site could flow eastward toward Dry Auglaize Creek. However, according to Figure 15 "Generalized direction of groundwater flow in the Niangua, Osage Fork, and Grandglaize basins" published in the Water Resources Guide No. 35, groundwater beneath the site could flow northwestward toward the Niangua Arm of the Lake of the Ozarks. Furthermore, dye traces have shown that surface water lost in Dry Auglaize Creek can cross the surface water divide and discharge into the Niangua River, northwest of the site. It is possible that both groundwater flow directions are correct. Shallow groundwater may flow toward Dry Auglaize Creek, while deeper groundwater may be diverted into the Niangua Basin.

Monitoring well nests are needed to accurately determine the magnitude of the downward vertical gradient. The upper Gasconade Dolomite *may* inhibit the downward migration of contamination. However, fracturing and karst development may have resulted in a local increase in permeability within the otherwise relatively tight upper Gasconade Dolomite.

The Gunter Sandstone is generally highly porous and permeable and is an important source of domestic groundwater supplies in the area. Because the Gunter Sandstone generally yields adequate domestic water supplies, few private wells in the area penetrate the underlying Cambrian Formations. However, municipal wells in the Lake of the Ozarks area are generally cased through the Gunter Sandstone, in order to avoid possible bacterial contamination.

The Eminence and Potosi Dolomites are a major source of municipal drinking water throughout the Ozark area, including the City of Camdenton. The Eminence Dolomite is differentiated from the underlying Potosi Dolomite by the lack of druse. A druse is a rock cavity encrusted with finely crystalline quartz. The druse-rich Potosi Dolomite is the most permeable geologic unit within the Ozark Aquifer and generally has an extensive network of karstic channels.

The shallowest reliable aquitard beneath the site is the St. Francois Confining Unit, approximately 1,150 feet below the surface. The St. Francois Confining Unit separates the Ozark Aquifer from the deeper St. Francois Aquifer. The St. Francois Aquifer includes the Cambrian-age Bonneterre Formation and Lamotte Sandstone. The St. Francois Aquifer is not used as a water source in Camden County. Water losses in the Lamotte Sandstone are common in some parts of the Ozark Region, although the phenomenon is poorly understood. Outside the St. Francois Mountain area, few water wells penetrate the Lamotte Sandstone, since yields may actually be reduced. Groundwater flow directions in the deeper St. Francois Aquifer are generally unknown and may be complicated.

Baseline water-level and pumping rate data need to be collected before informed decisions about groundwater movement in the Camdenton subsurface can be made. Static water levels should be measured at least monthly at any inactive wells. Detailed records of active wells should include volume of water pumped, length of pumping cycles, and drawdown measurements.

There are no aquifer discontinuities within a four-mile radius of the site. Folds and faults in the area cannot be considered aquifer discontinuities because their effects on groundwater movement are so poorly understood. Older faults have more highly-developed solution channels and may, therefore, act as groundwater conduits. Younger faults can actually act as aquitards, inhibiting groundwater flow.

Wellhead Protection Area

The Camdenton Sludge Disposal Area is located in Area 1, as designated by the DGLS Wellhead Protection Section. Since September 1987, Area 1 bedrock wells have been required to have 80 feet of casing and penetrate at least 30 feet of bedrock.

Karst Features

The Camdenton Sludge Disposal Area is considered karst. Significant karst features are present within a four-mile radius of the site. Dissolution has caused the carbonate aquifers to be extremely heterogeneous.

Geologic Structures

Geologic structures can influence groundwater movement. The effects of the structural deformation on groundwater are poorly understood, but the faulting and folding has probably increased hydraulic conductivities in some areas. The northwest-trending structures in the Camdenton area tend to be older than northeast-trending structures. Northwest-trending structures may act as groundwater conduits.

Faults and folds have been mapped within four miles of the site. Well log data suggest unmapped faults may also affect the area. A circular area of complex brecciation, known as the Decaturville Structure, lies just southwest of the four-mile target radius. The Decaturville Structure is part of the Decaturville-Crooked Creek axis, a series of highly-faulted areas stretching eastward into Kentucky. The Mine Hollow Fault is located approximately 2/3 mile southeast of the Camdenton Sludge Disposal Area. The fault appears to radiate from the Decaturville Structure. The Mine Hollow Fault has a northeast trend and is downthrown approximately 60 feet to the northwest.

The axis of a northwest-trending syncline, called the Racetrack Hollow Syncline, has been mapped less than two miles west of the Camdenton Sludge Disposal Area. The Red Arrow Fault is located less than three miles southwest of the site. The Red Arrow Fault strikes northwest and, in general, the southwest side is downthrown approximately 100 feet. However, geology along the fault zone is complicated. LOGMAIN Well # 28602 is located along the western portion of the fault zone and indicates significant upward movement. Ha Ha Tonka Spring is located along the trace of the Red Arrow Fault.

The poorly defined Proctor anticline runs across Camden County. The Proctor Anticline changes to a fault in southern Camden County. The Proctor Fault has been mapped less than four miles northeast of the Camdenton Sludge Disposal Area. The structure is probably related to a rejuvenated Precambrian fault.

Table 2: Stratigraphic Column for the Camdenton Sludge Disposal Area, Camden County (after Harvey et. al.,1983)

System	Aquifer Group	Approximate Site – Specific Thickness (ft)	Formation	Hydraulic Conductivity (cm/sec)	Regional Thickness (ft)	Dominant Lithology	Water-bearing Character
Quaternary		10	Colluvium and residuum		0-90	Regolith of residual clay, sand, chert pebbles and cobbles	May contain small amounts of perched water.
Ordovician	Ozark Aquifer	50	Roubidoux Formation	10^{-3}	0-90	Clayey residuum, sandstone and sandy dolomite	Not present in sufficient thickness in the Camdenton area to produce usable quantities of water.
		280	*Gasconade Dolomite*	10^{-6}	300-385	*Cherty dolomite, minor* sandstone, and shale	*Yields moderate to large quantities* of water to wells. Yields range from 20 to 75 gpm. Less-permeable Upper Gasconade may act as a leaky confining unit.
		25	Gunter Sandstone Member	10^{-4}	10-45	Sandstone	Contributes moderate to large quantities of water. Most wells open to other formations.
Cambrian		550?	Eminence Dolomite	10^{-5}	240-635	Cherty dolomite	*Yields 6-100 gpm, the average* being about 20 gpm
		50?	Potosi Dolomite	10^{-4}	30-330	Dolomite; contains abundant quartz druse	Yields large quantities of water to wells. Yields range from 100 to 750 gpm.
	St. Francois Confining Unit	80	Derby-Doerun Dolomite	10^{-7}	80?-215	Shaley dolomites and shale	Reliable aquitard.
		80	Davis Formation	10^{-7}	50-380?		
	St. Francois Aquifer	90	Bonneterre Formation	10^{-5}	85-200	Dolomite and limestone	Generally used only in outcrop areas. May contribute additional 100-200 gpm to wells open to other formations.
		300	Lamotte Sandstone	10^{-5}	140-300	Sandstone and arkosic conglomerate	
Precambrian	Basement Confining Unit					Igneous and metamorphic rocks	Does not yield water to wells in this area

4.2 Groundwater Targets

Groundwater use within four miles of the site is extensive. At least 1,888 people are served by public wells in the area and an estimated 210 people are served by private wells. A detailed description of the well use follows.

Public Drinking Water Wells

Public Water Supply District (PWSD) #2 of Camden County has two drinking water wells within four miles of the site. Well #1 is located just east of Highway 5 at the Camdenton Memorial Airport, approximately 0.6 of a mile northwest of the sludge disposal area. The well was drilled in 1974 to a total depth of 848 feet with 330 feet of 6 inch steel casing. The pump is set at 415 feet. Records show the well only yields 83 gpm. PWSD #2 personnel reported that Well #1 is used as a reserve well, and is only turned on once a week for a maintenance check. Well #2 is located just east of Highway 5, approximately 3.1 miles south-southwest of the site. Well #2 was drill in 1995 to a total depth of 1,100 feet with 425 feet of 8 inch steel casing. The pump is set at 275 feet (Reference 31). PWSD #2 personnel reported that Well #2 is the primary well that supplies 99% of the water for the district. (Reference 5). Camden County PWSD #2 serves 800 people (Reference 32, p. 60).

The Southway Terrace Mobile Home Park well is located on Highway 5, approximately 2.2 miles northwest of the site. The well was drilled in 1970 to a total depth of 550 feet with 350 feet of six inch steel casing (Reference 33). This well serves 85 people (Reference 32, p. 120).

The City of Camdenton's Rodeo well is located on Rodeo Road in the City of Camdenton, approximately 3.6 miles northwest of the site. The Rodeo well was drilled in 1961 to a total depth of 940 feet with 450 feet of eight-inch steel casing. The pump is set at 420 feet. The yielding strata is the Potosi Dolomite. Records show the well yields 380 gpm (Reference 34). The Rodeo well would serve an apportioned 993 people (Reference 32, p. 14).

TABLE 3: PUBLIC WELLS WITHIN A 4-MILE RADIUS OF THE CAMDENTON SLUDGE DISPOSAL SITE

Distance from Site	Name of Well	No. of People Served*
1/2 - 1	Camden County PWSD #2 Well #1	Reserve Well Only
2-3	Southway Terrace MHP	85
3-4	Camden County PWSD #2 Well #2	800
	City of Camdenton's Rodeo Well	1,003
TOTAL		1,888

* Reference 32, pp. 14, 33, 120, 131

Private Drinking Water Wells

Within four miles of the site, there are 87 wells recorded in the DGLS databases. The LOGMAIN database contains information on older wells. The DGLS Well Wellhead Protection Section's Water Well Information System (W.I.M.S) database contains

information on wells drilled since 1987. The vast majority of the wells on record are domestic supply wells. Some wells may no longer be active, and many active wells may not be recorded in DGLS databases. Table 4 presents the breakdown of private wells within four miles of the site (Reference 30). The population served by private wells was calculated using the estimated average persons per household in Camden County - 2.41 (Reference 35).

TABLE 4: PRIVATE WELLS REGISTERED WITH DNR WITHIN A 4-MILE RADIUS OF THE CAMDENTON SLUDGE DISPOSAL SITE

Distance From Site	Number of Private Wells	Estimated Population Served
0 - 1/4	1	2
1/4 - 1/2	2	5
1/2 - 1	2	5
1-2	17	41
2-3	29	70
3-4	36	87
TOTAL	**87**	**210**

4.3 Previous Sampling

On August 3, 1998, sample 98-M225 was collected from a drinking water well at 3499 RR3, located on County Road 5-120 approximately 0.15 of a mile west-southwest of the Camdenton Sludge Disposal site. The homeowner had requested the City of Camdenton collect the sample because he was concerned about the proximity of his well to the sludge disposal area. The City of Camdenton's Public Works Director collected the sample, and sent it to DNR for analysis. The sample was analyzed for VOCs. TCE was detected at 13.1 ppb and cis-1,2-dichlorothene was detected at 0.6 ppb (Reference 36).

This result caused concern, and DNR requested a second confirmatory sample be collected. On August 23, 1998, the Public Works Director collected sample 98-M286 from the well at 3499 RR3. For this sample, the well was evacuated for at least 20 minutes. The sample was non-detect for all VOCs (Reference 37).

4.4 PA/SI Sampling Locations

Groundwater samples for the PA/SI were collected on January 6 and 29, 1999. One public water supply well and three private drinking water wells were sampled. Figure 3 in Appendix A shows sample locations for all groundwater samples collected as part of the Camdenton Sludge Disposal PA/SI (Reference 29).

DNR Sampling - January 6, 1999 (Reference 29)
Three private drinking water wells near the site were sampled on January 6, 1999. Two samples were collected from the well at 3499 RR3 (County Road 5-120), the one previously sampled in August 1998. The first sample was collected after evacuating the well for approximately 30 seconds. The second sample was collected after evacuating the

well for approximately 5 minutes. This technique was utilized due to the discrepancy in analytical results from previous samples that were collected after different intervals of evacuation. No information is known about this well.

The second well sampled was at the 3496 RR3 residence, located on County Road 5-120 approximately 0.25 of a mile southeast of the site. Only one sample was collected from this well. The well is reported to have been drilled in 1971 to a total depth of 528 feet with 40 - 45 feet of casing and the remainder open hole. The third well sampled was at the residence located directly across the road from the 3496 RR3 (County Road 5-120) residence. Only one sample was collected from this well. The well is reported to have been drilled sometime between 1956-1958 to a total depth of 280 feet.

Private Sampling - January 6, 1999 (Reference 38)
Later in the day on January 6, after DNR samples were collected from the residences at 3496 and 3499 RR3, the property owner at 3496 RR3 collected additional water samples from his well and the well at 3499 RR3 for independent analysis. The samples were analyzed at Environmental Analysis South, Inc. in Cape Girardeau, MO. The cost for analysis was paid for by the home owners. The samples were analyzed for TCE. The sample result from the well at 3499 RR3 showed 20 ppb TCE; the sample result from the well at 3496 RR3 showed 21 ppb.

DNR Sampling - January 29, 1999 (Reference 29)
Additional sampling was conducted at the 3496 and 3499 RR3 wells due to the discrepancies in analytical results from the samples collected on January 6, by the property owner and analyzed by Environmental Analysis South, Inc., and those collected and analyzed by DNR.

Both wells were resampled by DNR on January 29, 1999. Again, due to theories that the TCE was only being detected after a certain amount of purging, several samples were collected from each well at various intervals of evacuation. Samples were collected from the well at 3499 RR3 at three intervals of evacuation: 15 minutes, 45 minutes and 75 minutes. Four of the samples (including a duplicate) were marked for analysis by DNR. Two split samples were collected and marked for analysis by Environmental Analysis South, Inc. One split sample was collected and marked for analysis by Environmental Health Laboratory.

Samples were collected from the well at 3496 RR3 at four intervals of evacuation: 15 seconds, 15 minutes, 45 minutes and 75 minutes. Four of the samples were marked for analysis by DNR. Two split samples were collected and marked for analysis by Environmental Analysis South, Inc. One split sample was collected and marked for analysis by Environmental Health Laboratory.

Also sampled on January 29, 1999 was the Camden County PWSD #2 Well #1. One sample, 991496, was collected from the well after evacuating the well for 10 minutes.

4.5 Analytical Results (References 29; 38)

Private Drinking Water Wells

3496 RR3 Well

Sample 991456, collected by DNR from the 3496 RR3 residence on January 6, 1999, was analyzed by DNR for total metals (arsenic, barium, cadmium, chromium, copper, mercury, nickel, lead, selenium, silver) and VOCs. Barium was detected at 81.7 ppb, copper was detected at 12.8 ppb, and lead was detected at 17.7 ppb. The sample was non-detect for all VOCs.

As stated previously the sample collected by the home owner at 3496 RR3 (430115), on January 6, 1999, was analyzed by Environmental Analysis South, Inc. for TCE. Analysis showed TCE at 21 ppb.

Samples 991491, 991492, 991494, 991495, collected by DNR at staggered intervals of evacuation from the 3496 RR3 residence on January 29, 1999, were analyzed for VOCs only. No VOCs were detected in any of the samples. Samples 500730 (a split of 991491) and 500731 (split of 991494), were collected by DNR and analyzed by Environmental Analysis South, Inc. for TCE. No TCE was detected in either sample. Samples 991412 (a split of 991492) and 991413 (a split of 991494), analyzed by Environmental Health Laboratory, were non detect for all VOCs.

3499 RR3 Well

Samples 991454 and 991455, collected by DNR from the 3499 RR3 residence on January 6, 1999, were analyzed by DNR for total metals (arsenic, barium, cadmium, chromium, copper, mercury, nickel, lead, selenium, silver) and VOCs. In sample 991454, barium was detected at 46.4 ppb, copper was detected at 54.1 ppb, and lead was detected at 4.9 ppb. In sample 991455, barium was detected at 46.7 ppb, copper was detected at 11.5 ppb; lead was not detected. Both samples were non-detect for all VOCs.

As stated previously, the sample collected privately on January 6, 1999, of the 3499 RR3 residence (430114), was analyzed by Environmental Analysis South, Inc. for TCE. Analysis showed TCE at 20 ppb.

Samples 991487, 991488, 991489, 991493, collected by DNR at staggered intervals of evacuation from the 3499 RR3 residence on January 29, 1999, were analyzed for VOCs only. No VOCs were detected in any of the samples. Samples 500728 (a split of 991487) and 500729 (a split of 991488), were collected by DNR and analyzed by Environmental Analysis South, Inc. for TCE. No TCE was detected in either sample. Sample 991411 (a split of 991489), analyzed by Environmental Health Laboratory, was non detect for all VOCs.

Private Well Across from 3496 RR3 on County Road 5-120
Sample 991457, collected by DNR from the residence across the road from 3496 RR3 was analyzed for total metals (arsenic, barium, cadmium, chromium, copper, mercury, nickel, lead, selenium, silver) and VOCs. Barium was detected at 61.2 ppb and copper was detected at 20.2 ppb. The sample was non-detect for all VOCs.

Public Drinking Water Well
Sample 991496, the water grab from the Camden County PWSD #2 Well #1, was analyzed for VOCs. No VOCs were detected.

4.6 Groundwater Conclusions

With the exception of lead, detected in sample 991456 at 17.7 ppb, all metals detected in the private well samples were present at concentrations well below the MCLs. The lead in this groundwater sample is not thought to be related to the Camdenton Sludge Disposal Area site. Analytical results from soil samples collected from the disposal area do not show high levels of leachable lead.

At this time, the discrepancy in results between the samples collected from the 3496 and 3499 RR3 wells when TCE was detected and those when TCE was not detected, is inexplicable. QA/QC data on the two samples analyzed by Environmental Analysis South, Inc., that showed TCE at 20 and 21 ppb, has been reviewed by DNR's Environmental Services Program, and no problems were noted.

Additional sampling is necessary to determine the true nature of the potential contamination of groundwater in the area possibly due to the sludge disposal. Shallow bedrock monitoring wells near the site may help characterize the site conditions.

There are a number of private drinking water wells (at least 87) located within four miles of the site. The concern remains that the sludge deposited may have contained TCE that has infiltrated into the shallow bedrock aquifer. Karst conditions in the area may account for the aberrant nature of TCE detections in the private drinking water wells in the area.

5.0 SURFACE WATER PATHWAY

5.1 Hydrologic Setting

The Camdenton Sludge Disposal Area is situated near the crest of broad ridgetop that acts as the drainage divide between streams draining northwest, toward the Niangua Arm of the Lake of the Ozarks and streams draining east, toward the Dry Auglaize Creek. South and east of the site, unnamed streams flow southeast toward Forbes Branch. The natural landforms and drainage patterns at the site have been obscured by airport construction and soil disposal. The site itself has been leveled, while the surrounding terrain exhibits low natural relief (2% to 4% slopes). Land use patterns for the surrounding upland near

the Camdenton Sludge Disposal Area include residential and agricultural properties with some light-industrial use. The steeper slopes are generally forested (Reference 30).

Surface runoff from the sludge disposal area flows eastward toward Forbes Branch and Dry Auglaize Creek, both losing streams. The intermittent stream near the site flows for one mile before entering the intermittent Forbes Branch, which then flows 1.2 miles before entering the perennially-flowing Dry Auglaize Creek. Because the overland flow distance to the nearest perennial surface water is more than two miles, the surface water pathway is not evaluated for this site (References 3; 30).

5.2 Surface Water Conclusions

The surface water pathway is not evaluated due to an overland flow distance greater than two mile.

6.0 SOIL EXPOSURE AND AIR PATHWAYS

6.1 Physical Conditions

The native soil in the vicinity of the Camdenton Sludge Disposal Area is the Lebanon silt loam. Lebanon soils are deep, moderately well-drained soils typical of ridgetops. Permeability is moderate, although a shallow fragipan, if present, may perch water. Even if a fragipan is present, downward seepage is a potential concern (Reference 30).

The 40 acre site is an open field with grassy vegetation. The only structure on-site is the abandoned machinery used to spread the sludge during land application. There is no visible sludge on the surface. The sludge was reportedly spread, mixed and disced into the native soil (except for several piles in the ditch) and the area was then seeded. Visible sludge was only encountered in two of nine soil borings in the disposal area. It was green in color and definitely distinguishable from the surrounding soil. It was encountered at a 0.5' to 1' depth. Access is not restricted to the site (Reference 5).

6.2 Soil and Air Targets

Residential areas are located immediately west, east and south of the site. Two homes are located on County Road 5-120 within 0.25 of a mile of the site. The residence at 3499 RR3 is within 400 feet of the western edge of the site (Reference 5).

Approximately half of the City of Camdenton lies within four miles of the site (Reference 3). Camdenton has an estimated population of 2,544 people (Reference 35, p. 144). Table 5, on the following page, presents the breakdown of the number of people estimated to be within a four-mile radius of the site (Reference 39).

TABLE 5: ESTIMATED POPULATION WITHIN A 4-MILE RADIUS	
RADIUS	POPULATION
ON-SITE	0
0 - 1/4	4
1/4 - 1/2	46
1/2 - 1	51*
1 - 2	583
2 - 3	428
3 - 4	1,233
TOTAL	2,345
*This value was calculated from a house count of the 1/2 to 1 miles radius ring.	

6.3 Soil and Air Conclusions

All soil samples collected as part of the PA/SI were waste/source samples. Residual sludge material was visible in two samples near the surface (0.5'-1' depth), but the field is well vegetated and is not currently used for any purpose. The risk of exposure to trespassers or passers-by would be minimal. Residential areas are located immediately west, east and south of the site. Two homes are located on County Road 5-120 within 0.25 of a mile of the site. Access to the site is not restricted.

7.0 SUMMARY AND CONCLUSIONS

The Camdenton Sludge Disposal site is located three miles southeast of the City of Camdenton on County Road 5-120, immediately southeast of the Camdenton Memorial Airport. The Camdenton Sludge Disposal Area is the site where sludge from the Hulett Lagoon, one of the City of Camdenton's wastewater lagoons, was deposited in 1989 as part of closure. The actual lagoon is located in the City of Camdenton, over four miles from the sludge disposal site, and is being investigated separately as the Former Hulett Lagoon site. The Former Hulett Lagoon site has documented TCE contamination in the soil and groundwater on-site.

From July 1989 to March 1990, over 2,000 cubic yards of sludge from the Hulett Lagoon were transported to the Camdenton Sludge Disposal Area for land application, as per the approved closure plan. The sludge was spread, mixed and disced into fields a total of approximately 20-40 acres in size. In March 1990, the fields were seeded with a mixture of Timothy and Fescue grasses in order to provide ground cover and prevent erosion. The field has been unused ever since.

Camdenton Sludge Disposal Area
Combined PA/SI
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Due to the documentation of remaining TCE in the soils at the former lagoon and the highly contaminated groundwater in that area, there was concern that the sludge deposited near the airport may still contain TCE that could be released into groundwater in that area. In August 1998, a sample collected from a private drinking well 500 feet west of the sludge disposal site showed 13.1 ppb TCE. Investigation of the sludge disposal area site was initiated in October 1998.

Waste/Source Sampling

The majority of PA/SI sampling in the sludge disposal area focused on the region near the main drainage ditch, which runs southeast to northwest across the southern portion of the site. It was reported that several loads of sludge were deposited into this ditch near the end of the project without any mixing, discing or spreading. Recognizable sludge material was encountered in two soil borings from the ditch. Levels of chromium, copper, lead and nickel were documented significantly above background in these two samples. Chromium, however, was the only compound detected that was present at a level exceeding the SCDM benchmarks and the MO ASL. TCE was not detected in any of the eight soil samples collected from the disposal area.

Groundwater

One public drinking water supply well and three private drinking water wells were sampled during the PA/SI. No VOCs were detected in the public well. On January 6, 1999 the two closest private drinking water wells to the site were sampled. Samples were collected by DNR for analysis at ESP and additional samples were collected by the home owners for analysis at a private lab. The DNR samples were non-detect for TCE, while the samples from the private lab showed TCE at 20 and 21 ppb. Due to the TCE detection, several additional samples were collected from the wells on January 29, 1999. Fifteen samples were collected, including duplicates and splits, at four different intervals of well evacuation. The samples were analyzed at three separate laboratories. All were non-detect for VOCs. At this time, the reason for the discrepancy in results between the samples collected on January 6 is unknown. Karst conditions in the area may account, in part, for the aberrant nature of TCE detections.

Groundwater use within four miles of the site is extensive. At least 1,888 people are served by public wells in the area and an estimated 210 people are served by private wells. The concern remains that the sludge deposited may have contained TCE that has infiltrated into the shallow bedrock on-site. Additional sampling is necessary to determine the true nature of the potential contamination of groundwater in the area possibly due to the sludge disposal. Shallow bedrock monitoring wells near the site may help characterize the site conditions.

Surface Water

The surface water pathway for this site was not evaluated because the overland flow distance to the nearest perennial surface water is more than two miles.

Soil and Air

All soil samples collected as part of the PA/SI were waste/source samples. Residual sludge material was visible in two samples near the surface (0.5'-1' depth), but the field is not used for any purpose. The risk of exposure to trespassers or passers-by would be minimal. Residential areas are located immediately west, east and south of the site. Two homes are located on County Road 5-120 within 0.25 of a mile of the site. The residence at 3499 RR3 is within 400 feet of the western edge of the site. Access to the site is not restricted.

8.0 RECOMMENDATIONS

Further CERCLA investigation is recommended at this site. Although there were at least ten samples that were non-detect for TCE in the two private drinking water wells, the three TCE detections cannot be dismissed. The karst nature of the geology in the area could account for the aberrant nature of TCE detections. The concern remains that the sludge deposited may have contained TCE that has infiltrated into the shallow bedrock on-site. Groundwater use, both public and private, within four miles of the site is extensive. Additional groundwater sampling is necessary to determine whether TCE is present in the bedrock beneath the site. Shallow bedrock monitoring wells near the site may help characterize the site conditions.

Camdenton Sludge Disposal Area
Combined PA/SI
March 30, 1999

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APPENDIX A
FIGURES

Figure 2: Camdenton Sludge Disposal Area
Soil Sampling Locations

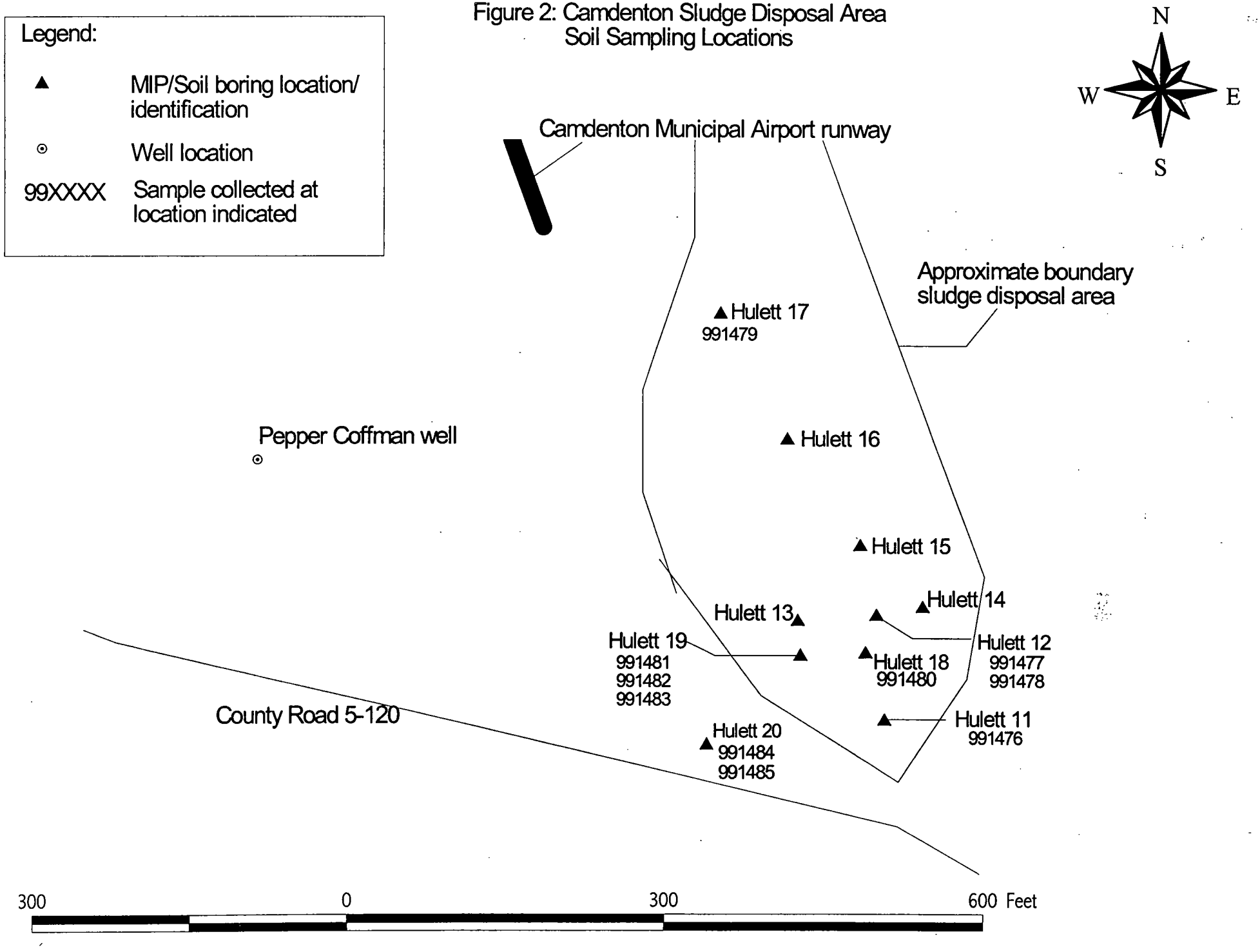


Figure 3: Camdenton Sludge Disposal Area Well Sampling Locations

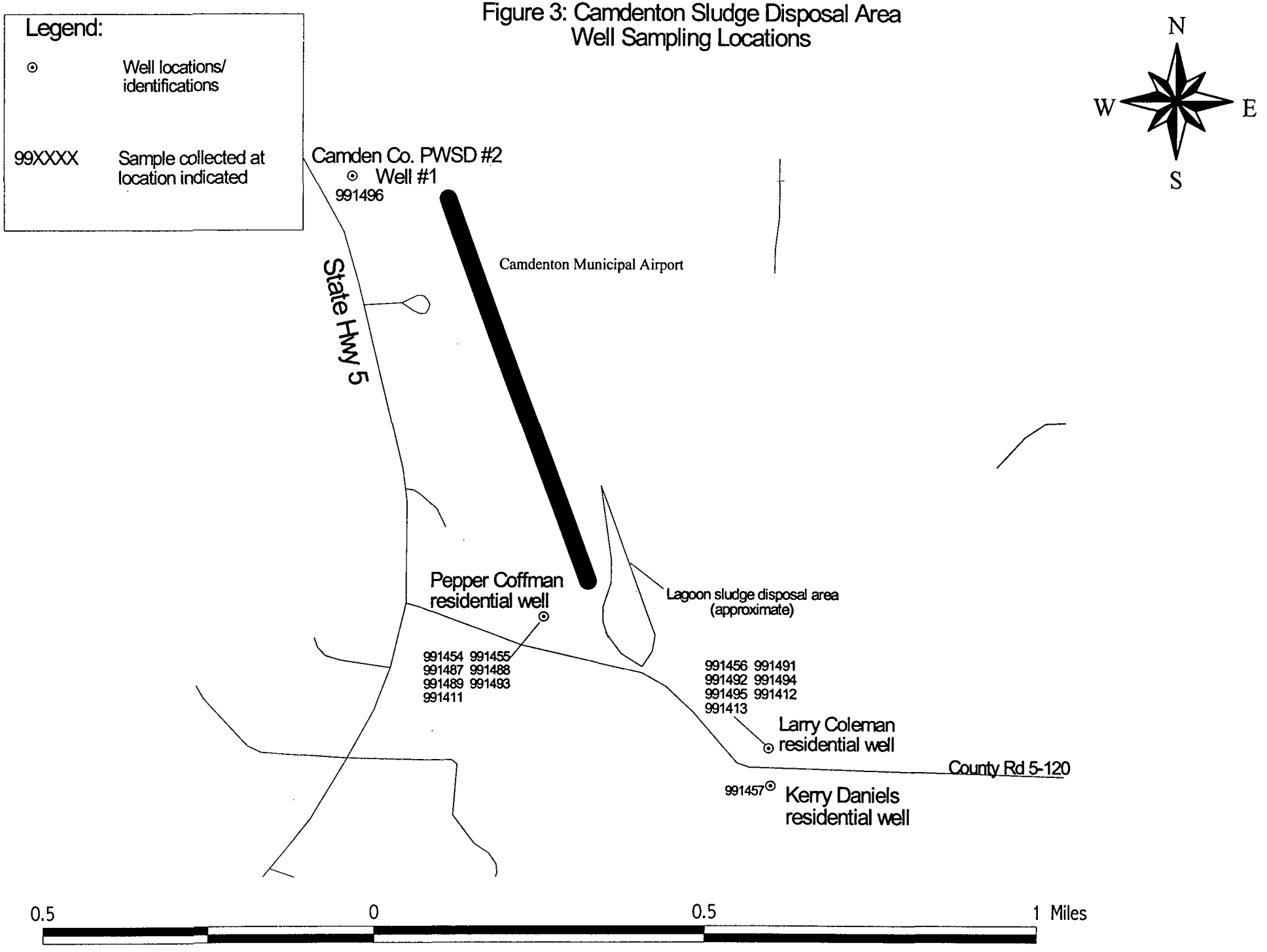
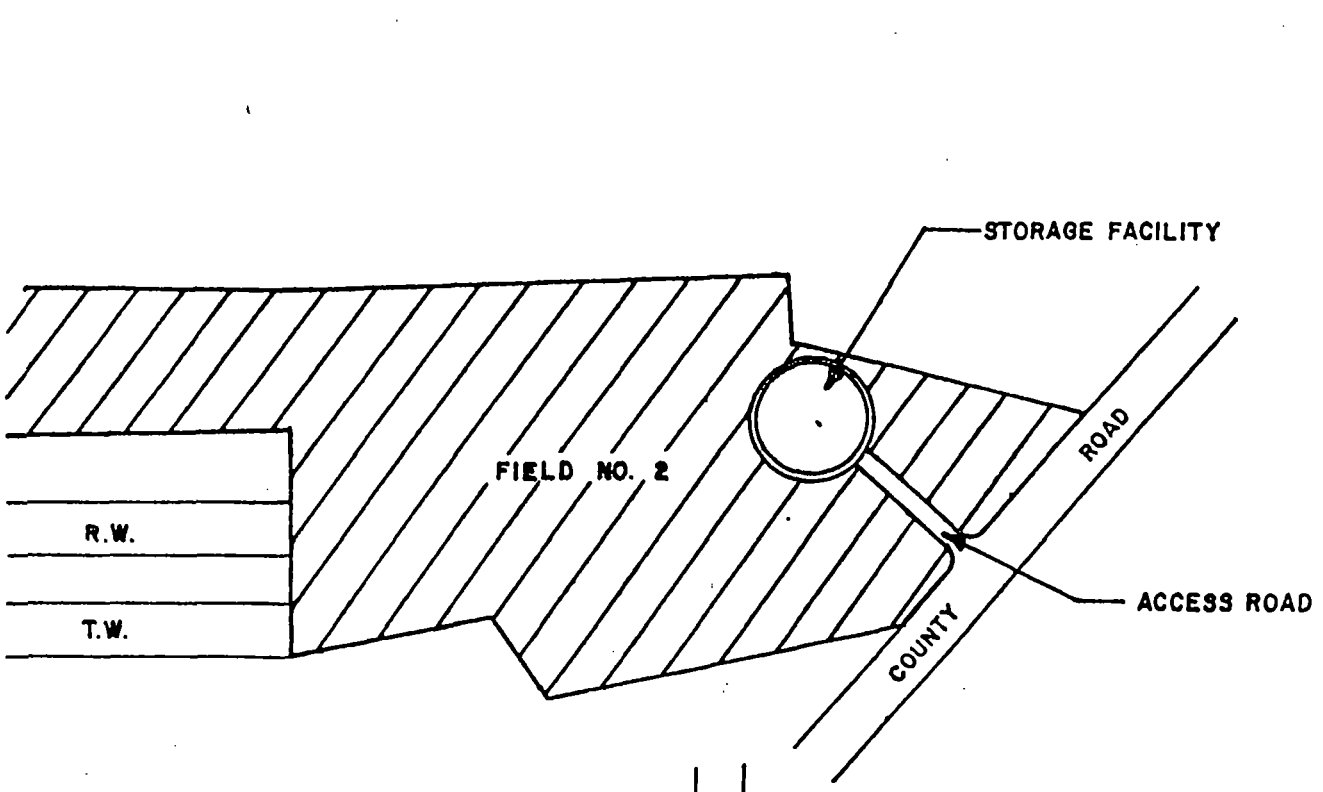
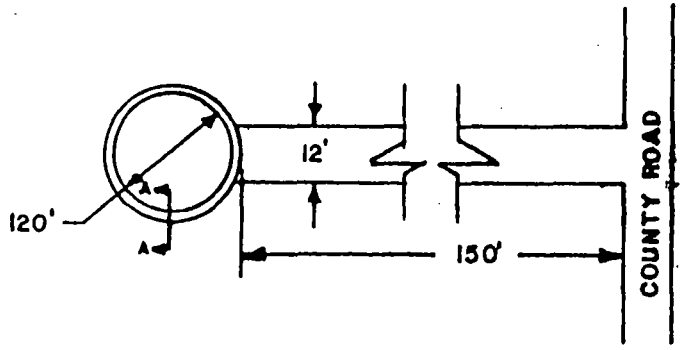
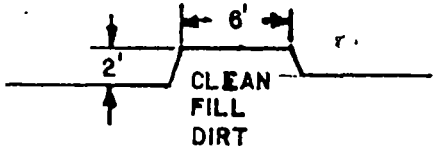


FIGURE 4







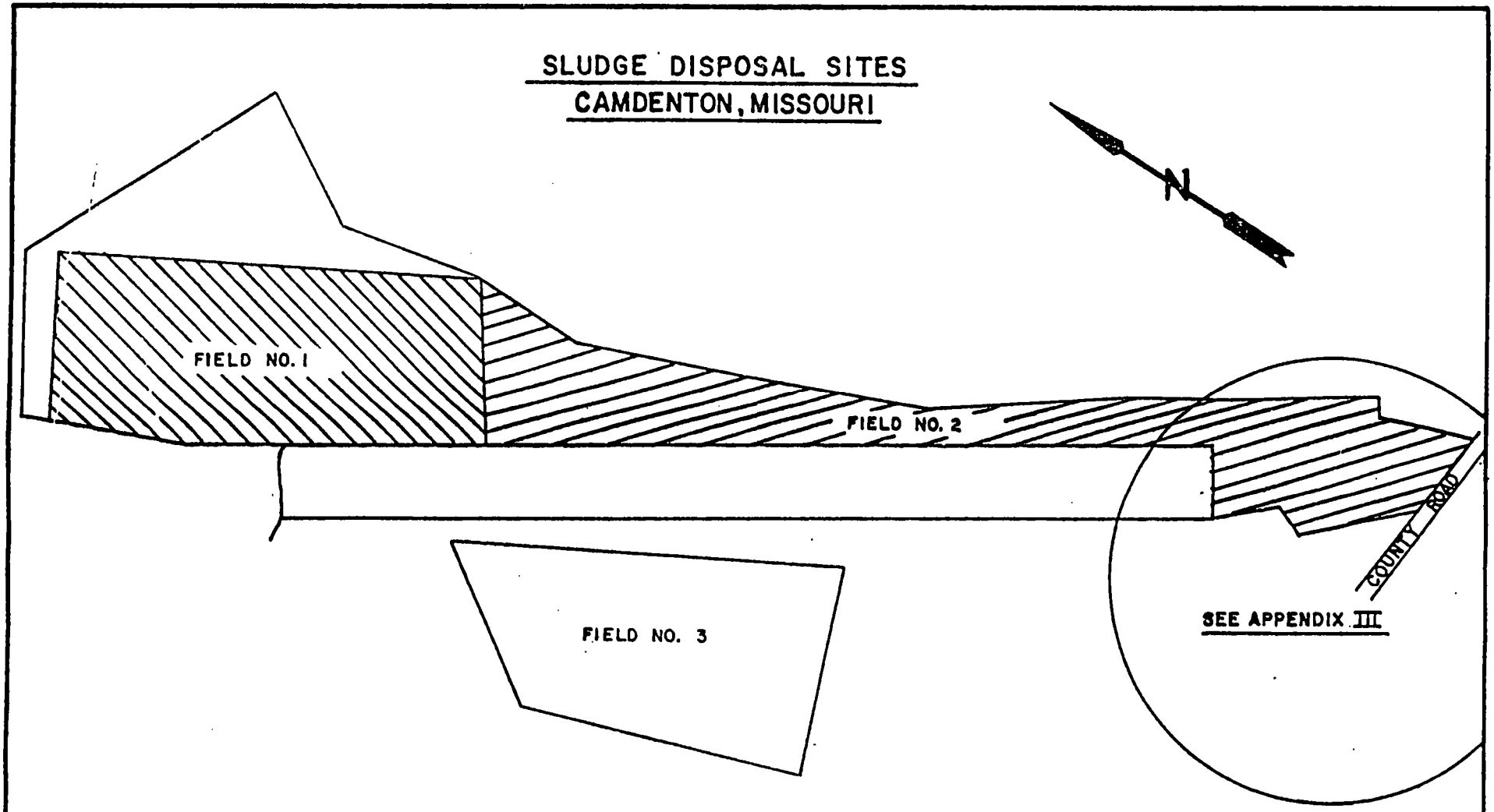
SECTION A-A

ACCESS ROAD & STORAGE FACILITY

APPENDIX III

MISSOURI ENGINEERING CORP. CONSULTING ENGINEERS ROLLA, MISSOURI		
DRAWN BY	SCALE 1"= 200'	DRAWING NO.
CK'D. BY	APP'D. DATE	APPENDIX III

FIGURE 5



NOTE: FIELD NO.2 AND PART OF FIELD NO.1 TO BE USED FOR DISPOSAL.

MISSOURI ENGINEERING CORP. CONSULTING ENGINEERS ROLLA, MISSOURI		
DRAWN BY	SCALE NONE	DRAWING NO. APPENDIX II
CK'D. BY	APP'D. DATE	

PHOTO 1

Former Hulett Lagoon Site. Camdenton, MO, Camden County. Photo taken on 10/1/74 by Ronnie Testerman, MDNR, JCRO. View looking northeast at the Hulett lagoon during operation. The northern portion of the lagoon shown in the photo was where influent from domestic sewage entered the lagoon. A small amount of the sludge from the Sundstrand influent, which came in on the south portion of the lagoon can be seen in the foreground of the photo near the wooden catwalk.

PHOTO 2

Former Hulett Lagoon Site. Camdenton, MO, Camden County. Photo taken on 10/1/74 by Ronnie Testerman, MDNR, JCRO. View looking east at the Hulett lagoon during operation. The picture was taken to show the sludge settling around the influent pipe area from Sundstrand.

PHOTO 3

Former Hulett Lagoon Site. Camdenton, MO, Camden County. Photo taken sometime in June or July 1989 by Ronnie Testerman, MDNR, JCRO. View looking northeast at the Hulett lagoon during the beginning of the closure process. The dewatering had begun, but no sludge had been removed.


'99 12:
4


'99 12:
5


'99 12:
6


'99 12:
7

Camdenton Sludge Disposal Area Site. Camden County, MO.
Photo taken on 1/21/99 by Valerie Wilder, Superfund, MDNR.
Photo taken looking west at the western portion of Field #2 just southeast of the Camdenton Memorial Airport runway.

VW

Camdenton Sludge Disposal Area Site. Camden County, MO.
Photo taken on 1/21/99 by Valerie Wilder, Superfund, MDNR.
Photo taken looking south-southeast at the Field #2 and the stockpiling area (on the left). County Road 5-120 can be seen in the back of the photo.

VW

Camdenton Sludge Disposal Area Site. Camden County, MO
Photo taken on 1/21/99 by Valerie Wilder, Superfund, MDNR.
Photo taken looking southeast at the former stockpiling area.
The circular pattern of the area is faintly discernable.

VW

Camdenton Sludge Disposal Area Site. Camden County, MO
Photo taken on 1/21/99 by Valerie Wilder, Superfund, MDNR.
Photo taken looking northwest at the northwestern portion of Field #2 located just southeast of the Camdenton Memorial Airport runway.

VW

8

Camdenton Sludge Disposal Area Site. Camden County, MO
Photo taken on 1/21/99 by Valerie Wilder, Superfund, MDNR.
Photo taken looking southeast at the eastern portion of Field #2. The low ditch area that receives most of the drainage fro the site can be seen in the middle of the photo.

VW

Camdenton Sludge Disposal Area Site. Camden County, MO.
Photo taken on 1/21/99 by Valerie Wilder, Superfund, MDNR.
Photo taken looking southwest at the abandoned machinery used to spred the sludge during the land application activities from December 1989 through March 1990.

VW

Camdenton Sludge Disposal Area Site. Camden County, MO.
Photo taken on 1/21/99 by Valerie Wilder, Superfund, MDNR.
Photo taken looking southeast the low ditch area of Field #2 that receives most of the drainage from the site.

VW